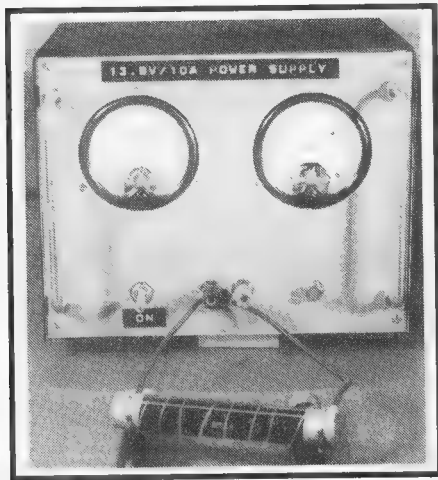


■ Power Supplies

"Miser's" 13.8 volt 10 or 20 amp Power Supply

Drew Diamond VK3XU and Ray Dean VK3RD** explain how to build a very useful and relatively cheap power supply.*



Drew Diamond's 10 A PSU delivering 11.5 A.

When it is necessary to operate a 12 V DC device from an AC mains outlet, a DC power supply unit (PSU) is required. Generally, a fully regulated, quiet PSU with a continuous capacity of more than a few amps is a costly item. However, amateurs take pride in being able to make things at minimum material cost, and certainly the construction of a home-made PSU is an ideal project for the resourceful builder. It is over ten years since the late Des Greenham described his popular home-brew power supply [Reference (2)] in *Amateur Radio*. Unfortunately, the UA78MG regulator chip used in that design has become hard to get, so what

follows is offered as a workable, and hopefully improved, pattern using presently obtainable components.

For many of us, the most expensive item would probably be the power transformer, a component costing anything up to \$100 at present. However, as is well known [see References (1), (2) and (3)], a practical solution is to re-wind the secondary of a transformer rescued from a junked TV set. Filter capacitor(s), diodes, heatsinks, meters and other components can be purchased at hamfest sales, bartered with radio friends, or bought new if necessary. More later.

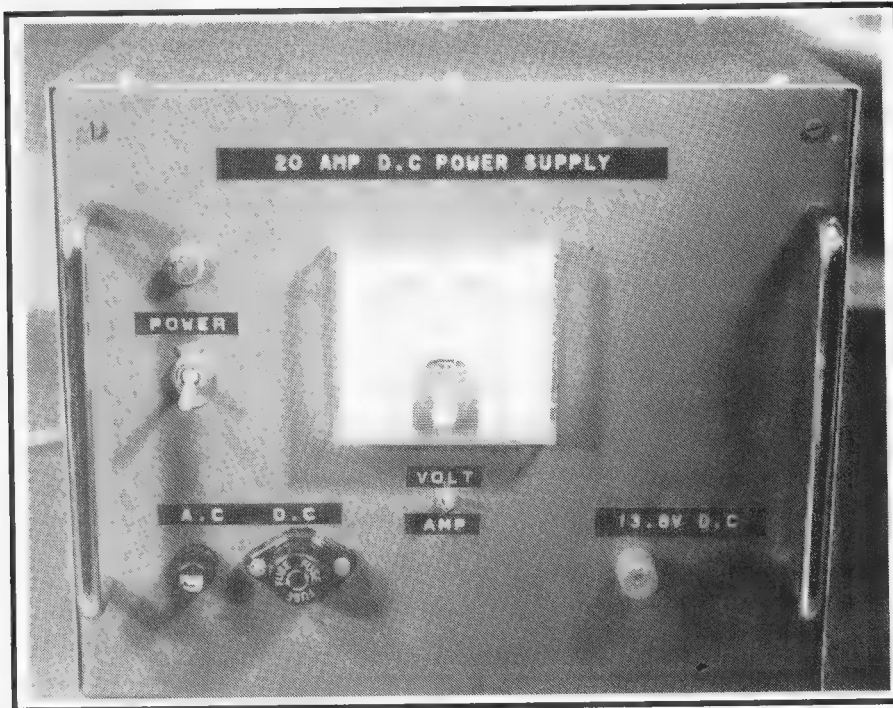
Performance

- Output Voltage:** Nominally 13.8 VDC (ie that of a good car battery, engine running).
- Output Current:** Conservatively 10 A or 20 A at 60% duty cycle.
- Line Regulation:** Less than 10 mV change in output from 230 to 250 VAC mains input voltage.
- Load Regulation:** Less than 10 mV fall in output voltage from no-load to full load.
- Ripple & Noise:** Less than 5 mV p-p at full load.
- Current Limit:** Set at 10 A or 20 A
- Output Protection:** Reverse voltage and over-voltage.

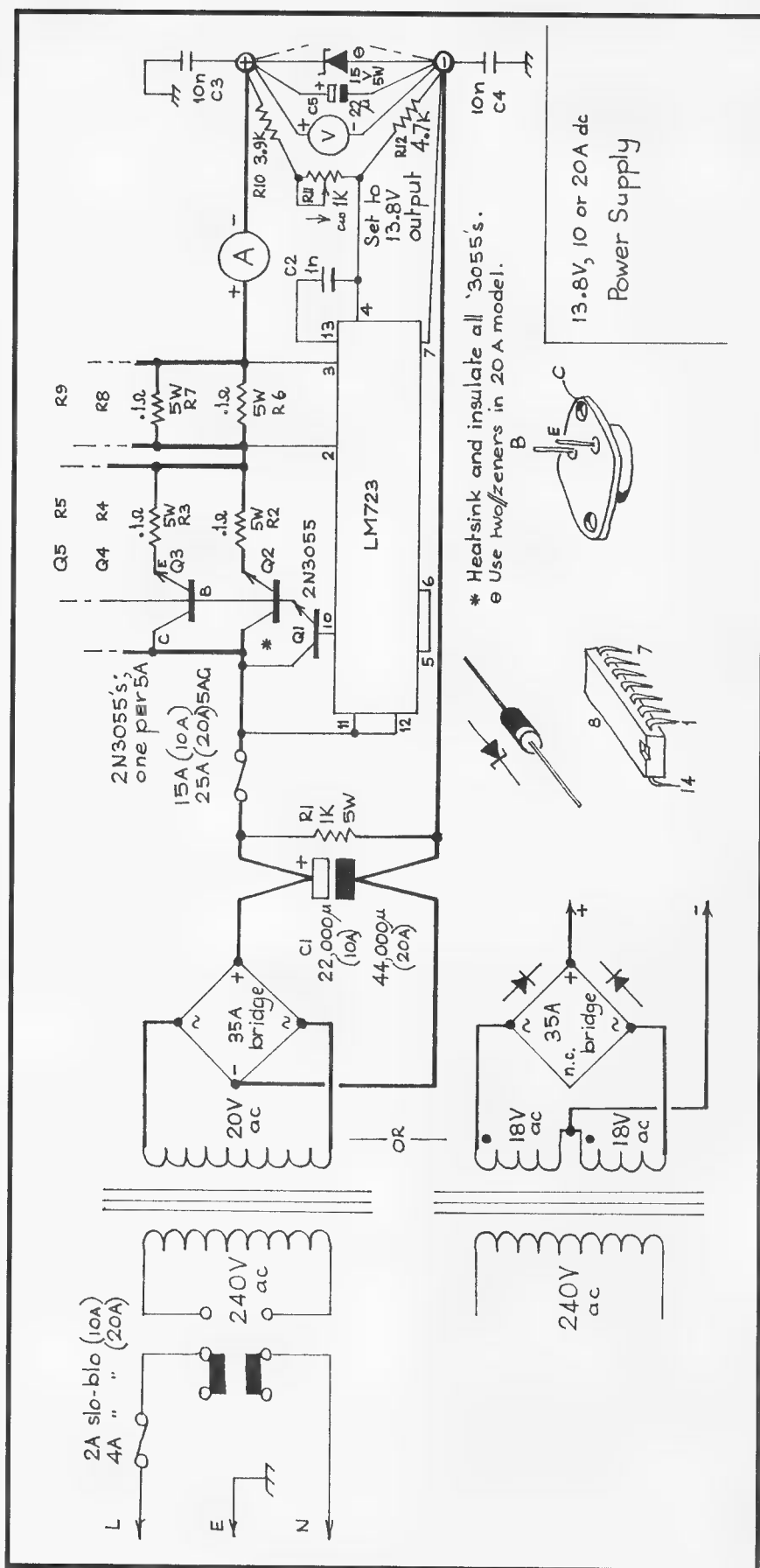
Circuit

The circuit is conventional. The 20 VAC output from the transformer is rectified, and the "raw" DC is applied to filter capacitor C1, which supplies smoothed, but as yet, unregulated DC at about 25 V with no load. C1 has a 1 k bleed resistor R1 connected to discharge C1 when mains power is removed. An LM723 (an oldie but a goodie, and readily available) performs the regulating function.

Output voltage is sampled right at the output terminals, and is injected into the invert input at pin 4. Error signal at pin 10 sources a Darlington connected 2N3055 at Q1, which drives the parallel connected 2N3055 pass transistors Q2 – Q3 (and Q4 – Q5 in the 20 A version).



Ray Dean's 20 A PSU.



To force current sharing (up to 5 A each), 0.1 ohm resistors are connected in the emitter lead of each pass transistor.

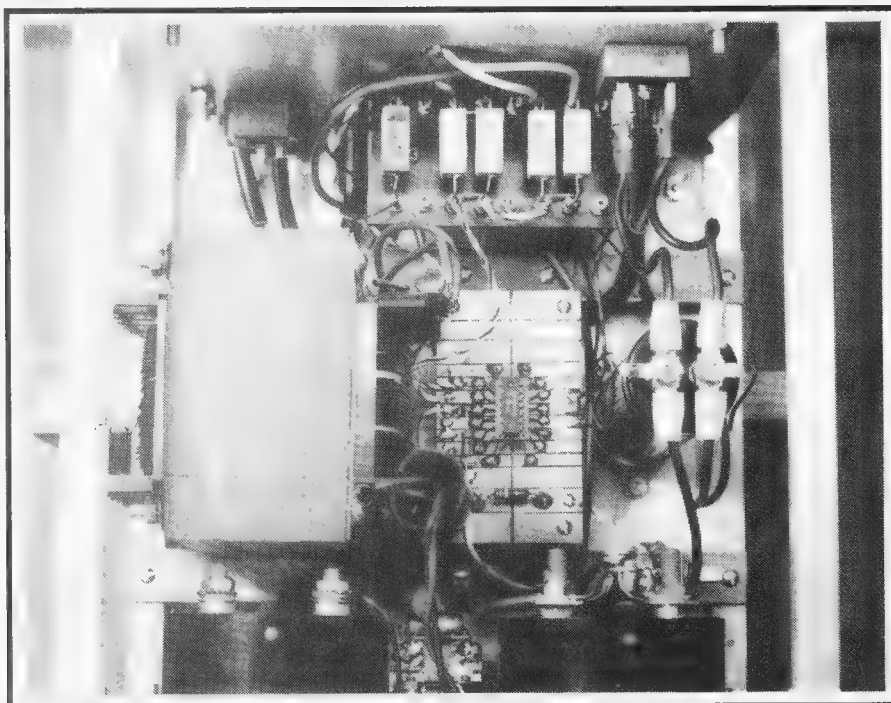
The voltage developed across the sense resistor comprised of two (or four) 0.1 ohm resistors in parallel at R6 – R7 (and R8 – R9) supplies the current limit signal into the '723 at pins 2 and 3. So, as the voltage developed across the effective 0.05 ohm (or 0.025 ohm) approaches 0.6 V, the '723 will cause the supply to go into the constant current mode, automatically limiting in response to any attempted demand beyond about 12 A (25 A).

HF instability is suppressed by inclusion of the 1 nF capacitor C2 between pins 4 and 13. RF is discouraged from entering the supply by inclusion of RF by-pass capacitors C3 and C4 connected from each output terminal to chassis ground. The output “floats” so that positive-earth devices may be powered if necessary.

Reverse voltage and over-voltage protection is provided by the simple trick of connecting one or two 15 volt 5 W "sacrificial" zener diodes at the output terminals (much simpler than crowbar, and not prone to false triggering). Should one of the pass transistors unfortunately fail, and short between collector and emitter, the diode(s) will zener at 15 Volts. The DC fuse will blow, disconnecting DC power and thus protecting the load. The zener(s) will probably be destroyed (tests on numerous diodes, by deliberately shorting one pass transistor always caused a 5 W diode to short), but replacement of this part is nothing compared to the damage which would almost certainly result from the application of perhaps 20 V or more to your valuable transceiver.

Construction

To assist in heat transfer, and improve immunity to external RF fields, a metal case, box or cabinet is to be preferred. Actual size and shape is largely dictated by the major components, the transformer, heatsink and filter capacitor. The 10 A model is housed in a home-made aluminium box measuring 220 x 226 x 170 mm WDh. Front and rear panels are of 3 mm thick material, connected with 220 mm



Internal view of the 10 A PSU.

lengths of 10 mm square section aluminium rod. The 20 A model measures 300 x 250 x 250 mm WDH, using the classic U style aluminium box chassis.

The job of re-winding a suitable transformer has been well covered in references (1), (2) and (3). We would just add the following; wind on two or three more turns than calculated. If there has been some small error, it is easier to remove turns, rather than add, after the lamination stack has been re-assembled and tested. If a choice of "re-windable" transformers exists, use one that is perhaps larger than necessary. The well-known split-bobbin B&W TV types are certainly easy to work with but, in reality, these may not be capable of sustaining a 200 VA load (that's 20 VAC at 10 A effective secondary load for the 10 A model) for very long without overheating.

A workable estimation of the VA rating may be calculated from $VA = (a \times 0.865)^2$, where a is the area of the bobbin window in square cm. For example, say the window measures 4 x 5 cm = 20 sq cm, then $(20 \times 0.865)^2 = 299$ VA. A core of this size should be adequate for a 10 A supply. An extra clue is to measure the DC resistance of the 240 VAC primary winding; a reading

of about 3 to 5 ohms is typical for a 300 VA, and about 7 to 10 ohms for a 170 VA. A 500 VA would suit the 20 A model. By the way, when measuring the primary resistance of a good transformer, note how sluggishly an analogue meter needle moves off zero then creeps towards final reading. When you reverse the leads it is even more sluggish, indicating a large inductance of the primary winding.

If you want to buy new, some of the usual electronics retailers have transformers which should suit the 10 A model. The secondary voltage must be at least 18 VAC, and preferably 20 VAC (but not much higher than 20 V). Because, in normal working, we only transmit for up to half the time, it might be assumed that a 5 A winding will do for a 10 A transmitting load. However, much improved regulation and reliability will be obtained if the transformer is matched to the actual maximum current demand.

The transformer primary must be fused and switched as shown. Use a 2 A or 4 A slo-blo fuse in the line (brown wire) side. All mains connections **MUST** be adequately insulated or covered to prevent accidental contact, and the mains earth connected to chassis ground with a dedicated (ie not shared

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**BALLARAT CONVENTION
A GREAT FAMILY DAY.**

What a great turnout at the recent Ballarat convention. It was particularly noteworthy due to the combining of the Hamfest with the local Sunday Market and a Kite Flying Competition. It meant that there was lots of activities and entertainment for the ladies and children on the day, leaving the OMs to relax and look around the Ham goodies! Future convention organisers should keep Ballarat's success in mind...remember to cater for the whole family!

**NEW COMPUTER
CONTROLLABLE HANDHELD
WIDE BAND RECEIVER
ARRIVES!**

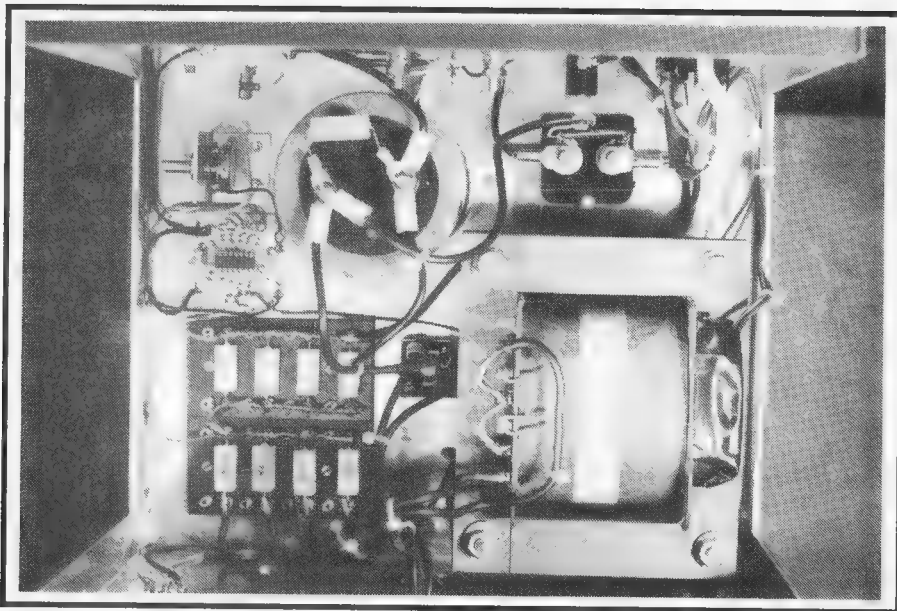
An exciting new Icom product has arrived...the IC-R10 Computer Controllable Handheld Wide Band Receiver and will be a real winner! 500KHz-1300MHz/AM/FM/WFM/USB/LSB/CW and priced at \$765 (R.R.P. inc tax). Great value for a unit of this quality and performance.

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Internal view of the 20 A PSU.

with any other function) screw, lug, lock-washer and nut.

A linear power supply, when worked hard, generates a considerable amount of waste heat, which needs to be effectively dissipated. Do not skimp on heatsinking for the pass transistors. The two (10 A) or four (20 A) pass transistors must be fitted to an appropriately sized heatsink or sinks. That shown for the 10 A model measures 160 x 110 x 60 mm, and must be at least twice as big for the 20 A model. Always incline on the side of largeness, it will not be wasted. Remember, your PSU must give long, reliable service.

Quite good heatsinks may be obtained from junked colour TV sets, old main-frame computers, etc. Fins should run vertically for best effectiveness. Include the necessary insulating hardware and apply a safe heatsink compound or vaseline at the interface. Do not overtighten the fixing screws. After assembly, with your multimeter on ohms, check that no shorts exist between the '3055 collectors and the heatsink. The Darlington driver Q1 may also be fitted to the main heatsink, or the rear panel as desired.

A 4-diode bridge will drop a total of about 1.2 V in each direction (0.6 V per conducting diode). If your transformer has, say, two separate 18 V/5 A or 8 A windings (giving 10 or 16 A DC output), then improved efficiency will be had by

using the windings in series, the centre tap being negative common, then one diode in each leg as shown as an alternative on the circuit. The diodes may be separate, or two diodes of a 4-diode bridge. Use a bridge with a rating of at least 25 A, and preferably 35 A at only slightly higher cost. The bridge assembly must be bolted to the bottom or rear panel, to act as a heatsink for this part.

An accepted rule of thumb for the main filter capacitor is about 2000 μF per amp of maximum current demand. A safe working voltage rating in this instance would be 35 V. "Computer grade" capacitors are the preferred type. If necessary, the required capacitance may comprise several smaller capacitors connected in parallel.

For ease of construction, the '723 may be fitted into a wire-wrap IC socket which, in turn, is soldered to a home-made circuit board. A rectangle of circuit board may be divided into lands or pads with a junior hacksaw, leaving spare lands for sense resistors R10 and R12. The lands form convenient tie points for wiring to other components. Carefully flare the IC socket pins to fit.

Make every joint a good one. Connections shown on the circuit with thick lines are those carrying substantial current, and should be made with insulated wire of at least 2 mm diameter copper. Ordinary hook-up wire will do for the remaining connections. For best

regulation to be obtained, the sense resistor connections must be wired away directly to the output terminals as shown on the circuit.

The 22 μF electrolytic, zener diode(s), voltmeter, and RF by-pass capacitors should be connected right at the output terminals. We suggest you make larger brass solder lugs for your terminals to accommodate these components. For an extra level of output protection (particularly for the 20 A model), use two zeners in parallel.

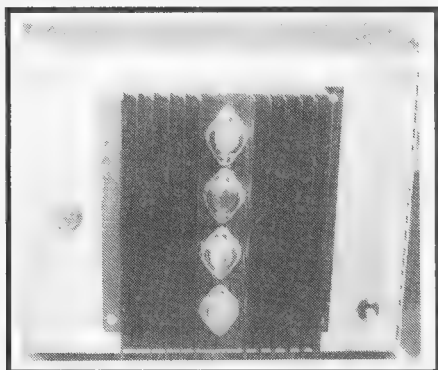
Meters are optional, although it is handy to know that the voltage is correct, and the amount of current being drawn. However, they are expensive items if purchased new. Those shown were obtained at modest cost from recent hamfests. Naturally, newer modern types command a higher price. Only the ammeters required the home-construction of a suitable shunt using Manganin resistance wire to convert a 1 mA meter to read 15 A or 25 A full scale deflection.

The 0.1 ohm (recent manufactured and marked R1, R being the decimal point) 5 W resistors may be mounted on an ordinary tag board or similar. Allow plenty of space between resistors, and make sure no other component or wire can come into contact with them.

Testing

Go over your wiring and confirm that all is correct. Pay particular attention to polarised components, including the filter capacitor, diode bridge, transistors, etc. With your multimeter on the highest ohms range, check that no stray grounds have occurred. When measuring between the positive terminal and chassis, then the negative terminal and chassis, you should read open circuit. The cause of a lower than megohms reading must be traced and rectified before applying power.

Remove the 15 or 25 A DC fuse, then apply mains power. Carefully measure the DC voltage across the main filter capacitor; it should be about 25 to 28 V. Switch off, then replace the DC fuse. Some output voltage should immediately appear due to the charge held by the filter cap. Apply power again. You should have about 13 or 14 V output. The voltage potentiometer



A typical heatsink arrangement on the 20 A PSU.

adjustment range is from about 13 to 14.2 V. Adjust the pot for 13.8 V.

Some sort of dummy load will be needed if you wish to test the PSU current capacity and voltage regulation. About 1.2 ohms (10 A) or 0.6 ohms (20 A) worth of resistance wire (probably nichrome) from an old heater element, and wound on a ceramic former, should do. Connection of the load should cause little or no change in output voltage, right up to, and probably a little beyond, the nominal maximum current capacity. Take care! The resistance wire glows red hot.

If desired, check the current limit function by temporarily applying a dead short across the output terminals. Voltage will fall to nearly zero, and current should limit at about 12 or 13 A (25 A). Removal of the short should restore output voltage, with no damage to the PSU.

Parts

The frugal procurement of the main components has already been mentioned. None of the parts is rare, but may seem costly if needed to be purchased new (and amateurs are notoriously penny-pinching aren't we?).

Near Melbourne we have the usual Dick Smith, Jaycar, Rod Irving, Altronics, TECS, etc electronics suppliers, and additionally Stewart Electronics and Rockby Electronics who can supply most of the required components. Rockby's (at writing) have a supply of reasonably priced 15,000 $\mu\text{F}/35\text{ V}$ caps. For heavier hook-up wire, try auto parts shops. The larger 5AG style fuse and holder (for the DC fuse in the 20 A model) are known to be available from Dick Smith Electronics.

Our 0.1 ohm 5 W resistors were purchased from Rockby and Stewarts. Sheet aluminium and square rod may be bought from Capral (Alcan) outlets (check their off-cuts bin). For transformer winding wire, look up "electric motor and generator repairs" in your Yellow Pages™. If you need some Manganin resistance wire for your ammeter shunt, or dummy load, drop a line to Drew at the address shown below (free plus postage).

References and Further Reading

1. *Home Brew Regulated Power Supply* – Greenham, VK3CO, AR Jul 87.
2. *Power Supply Transformers* – Switzer, VK2SR, AR Apr 87 (simple how to re-wind).

3. *Power Supplies on a Shoestring* – Case, GW4HWR, Rad Com, Jul 86 (transformer re-winding).

4. *13.8 V Power Units* – Hatch, G3ISD, Rad Com, Jul 83 (typical '723/3055 design methods).

5. *VK Powermate* – Simpson, Electronics Australia, May 78 (probably the one that started it all).

6. *VK Powermaster* – Electronics Australia, Mar 84 (became Dick Smith Kit 3448).

7. *"The Serviceman"* – Electronics Australia, Mar 92 (handy PSU troubleshooting tips).

8. *The Foolproof Power Supply* – Eunson, VK4SO, ARA, Vol 8 No 10.

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**19 Myoona Ave Mooroolbark 3138

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WIA News

US President Clinton Recognises Amateur Radio

The US President, Bill Clinton, sent greetings to radio amateurs in America in the lead up to the Simulated Emergency Test held over 12-13 October, recognising amateur radio's value to the community, particularly during emergencies, according to *The ARRL Letter Online*.

Referring to 7-13 October as "Amateur Radio Week", the text of the message, signed by President Clinton, said: *"In the past century, the medium of radio has changed the way we live and the way we view our world, and Amateur Radio operators have played a vital role in this communications phenomenon. Sharing knowledge and technological expertise, connecting computers via radio equipment, and linking people all across the globe, ham radio operators have helped to make our world a true global village. But even more important, they have provided a crucial lifeline of relief in times of disaster and hardship, ensuring that hope and help are on the way to those in need."*

"Amateur Radio Week offers us a welcome opportunity to thank our nation's amateur radio operators for their commitment to excellence and their willingness to work for the well-

being of others. Best wishes for a wonderful week."

Special Prefixes for Hongkong

Hongkong hams have gained permission to change the numeral in their call signs to commemorate the transfer of sovereignty over the territory from the United Kingdom to the People's Republic of China (PRC) on 1 July 1997.

From September, they've been able to use 96, for 1996. Next year, they will be able to use 97, and in 1998 they'll be able to use 98.

According to the Hongkong Amateur Radio Transmitting Society (HARTS), Hongkong amateurs previously holding VS6-prefix call signs are allowed to continue using them up to 1 July 1997, while VR2-prefix licences have been issued for several years now in anticipation of a prefix change after 1 July 1997.

The VRA-VRZ block allocated by the ITU to the UK will be transferred to the PRC at that time and will be used by the Hongkong Special Administrative Region of the PRC after the changeover date.

HARTS said that details of a new award for amateurs contacting stations using the special prefixes will be announced in the future.